CASIO

SUPER-FX

fx-3600Pv

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KEY INDEX

GENERAL KEYS

Key	Function	Page
ON	ON	5, 10
0 – 9, ·	Data entry	10
+, −, ×, ÷, =	Basic calculation	10
AC	All clear	9, 32, 34
C	Clear	9, 33
+/−	Sign change	8

MEMORY KEYS

Key	Function	Page
MR	Independent memory recall	9, 11
Min	Independent memory in	11
M+	Memory plus	11
M−	Memory minus	12
Kout	Constant memory recall	12
Kin	Constant memory in	12

SPECIAL KEYS

Key	Function	Page
SHIFT	Shift	12
MODE	Mode	5, 10, 15, 18, 21, 23, 25, 29, 36
[(⋯] [⋯)]	Parentheses	10
EXP	Exponent	8, 29
π	Pi	18
°'", ←°'"	Sexagesimal notation/decimal notation conversion	18

Key	Function	Page
X↔Y	Register exchange	10
X↔K	Register exchange	13
RND	Rounding off internal value	21

BASE-N KEYS

Key	Function	Page
DEC	Decimal	15
BIN	Binary	15
HEX	Hexadecimal	15
OCT	Octal	15
A – F	Hexadecimal numbers entry	15
AND	And	17
OR	Or	17
XOR	Exclusive Or	17
XNOR	Exclusive Nor	17
NOT	Not	17
NEG	Negative	16

FUNCTION KEYS

Key	Function	Page
sin	Sine	18
cos	Cosine	18
tan	Tangent	18
$\sin^{-1}$	Arc sine	19
$\cos^{-1}$	Arc cosine	19
$\tan^{-1}$	Arc tangent	19
hyp	Hyperbolic	19
log	Common logarithm	19
10^x	Common antilogarithm	20
ln	Natural logarithm	20
e^x	Natural antilogarithm	20

Key	Function	Page
$\sqrt{\ }$	Square root	20
x^2	Square	20
ENG, ENG	Engineering	21
$a\,b/c$, d/c	Fraction	13, 14
$\sqrt[3]{\ }$	Cube root	20
$1/x$	Reciprocal	19, 20
$x!$	Factorial	20
x^y	Power	20
$x^{1/y}$	Root	20
R→P	Rectangular to polar	22
P→R	Polar to rectangular	22
%	Percent	14
RAN#	Random number	21
nPr	Permutation	22
nCr	Combination	22

STATISTICAL KEYS

Key	Function	Page
KAC	Statistical register clear	23
DATA	Data entry	23
DEL	Data delete	24
x_D,y_D	Regression analysis data entry	25
$x\sigma_{n-1}$, $y\sigma_{n-1}$	Sample standard deviation	23
$x\sigma_n$, $y\sigma_n$	Population standard deviation	23
$\bar{x}$, $\bar{y}$	Arithmetic mean	23
n	Number of data	23
Σx, Σy	Sum of value	23
Σx^2, Σy^2	Sum of square value	23
Σxy	Sum of value product	
A	Constant term	25

Key	Function	Page
B	Regression coefficient	25
r	Correlation coefficient	25
$\hat{x}$, $\hat{y}$	Estimator	26

PROGRAMMING KEYS

Key	Function	Page
P1, P2	Program number	30, 31
RUN	RUN	29
HLT	HLT	31
ENT	ENT	29
RTN	Unconditional jump (return)	33
$x>0$, $x\leq M$	Conditional jump	34
PCL	Program clear	33

Dear customer,
Thank you very much for purchasing our electronic calculator.
To fully utilize its features no special training is required, but we suggest you study this operation manual to become familiar with its many abilities. To help ensure its longevity, do not touch the inside of the calculator, avoid hard knocks and unduly strong key pressing. Extreme cold (below 32°F or 0°C), heat (above 104°F or 40°C) and humidity may also affect the functions of the calculator. Never use volatile fluid such as lacquer thinner, benzine, etc. when cleaning the unit. For servicing contact your retailer or nearby dealer.

Before starting calculation, be sure to press the [ON] key and to confirm that "0." is shown on the display.

**Special care should be taken not to damage the unit by bending or dropping. For example, do not carry it in your hip pocket.*

INDEX

1 / GENERAL GUIDE

1-1 Modes

To put the calculator into a desired operating mode, or to select a specific angular unit, press [MODE] first, then [.], [EXP], [0], [1],... or [9].

[MODE][.] – RUN mode. Carry out manual calculation and program execution.
[MODE][EXP] – LRN is displayed. Program can be written.
[MODE][0] – BASE-N is displayed. Carry out Binary/octal/decimal/hexadecimal conversions, calculations and logical operations.
[MODE][1] – $\int dx$ is displayed. Integral can be carried out.
[MODE][2] – LR is displayed. Calculate regression analysis.
[MODE][3] – SD is displayed. Calculate standard deviation.
[MODE][4] – [D] is displayed. Use degrees as the unit of angle measurement.
[MODE][5] – [R] is displayed. Use radians as the unit of angle measurement.
[MODE][6] – [G] is displayed. Use grads as the unit of angle measurement.
[MODE][7] – Press any number from 0 to 9 to indicate how many decimal places you want displayed (FIX is displayed).
[MODE][8] – Press any number from 1 (1 digit) to 0 (10 digits) to indicate how many significant digits you want displayed (SCI is displayed).
[MODE][9] – Releases instructions entered in [MODE][7] and [MODE][8]. This operation also changes the range of the exponent display (see page 6).

1-2 The display

The display shows input data, interim results and answers to calculations. The mantissa section displays up to 10 digits. The exponent section displays up to ±99.

-E- or -[-	Error indication (see page 9).
[S]	Pressing of [SHIFT] (see page 12).
[M]	Pressing of [MODE] (see page 5).
M	Something is being stored in the memory (see page 11).
K	A constant is being used in calculations (see page 11).
hyp	Pressing of [hyp] (see page 19).
LRN	Learn mode (for programming) (see page 29).
BASE-N	BASE-N mode (see page 15).
$\int dx$	Integral calculation (see page 36).
LR	Regression analysis calculation (see page 25).
SD	Standard deviation calculation (see page 23).
[D] or [R] or [G]	Angular unit (see page 18).
FIX	Decimal places of a displayed value is being designated (see page 21).
SCI	Significant digits of a displayed value is being designated (see page 21).
P1	Indicates current program area is P1 (see page 29).
P2	Indicates current program area is P2 (see page 29).
ENT	You have just entered variable data into a program or it is time for you to enter variable data (see page 30).
45⌟12⌟23.	45-12/23 (see page 13).
12°3°45.6	12°3'45.6" (see page 18).

■ Exponential Displays

The display can show calculation results only up to 10 digits long. When an intermediate value or a final result is longer, the calculator automatically switches over to exponential notation. Values greater than 9,999,999,999 are always displayed exponentially, while the lower limit is selectable. Note the following:

Type	Lower limit	Upper limit
A (Norm 1)	0.01	9,999,999,999
B (Norm 2)	0.000000001	9,999,999,999

Values less than the lower limits or greater than the upper limit shown above are displayed using exponential format.
Use the following procedure to switch between the Type A lower limit and the Type B lower limit:
① Check the display to see if the FIX or SCI symbols are shown, indicating that the number of significant digits or the number of decimal places have been specified. If either of the symbols is shown, press [MODE][9] to cancel the specification.
② Perform the following calculation:

1 [÷] 200 [=]

③ Look at the display to see what the current lower limit is.

If the display reads:
5. $^{-03}$, the current setting is Type A | **5.** $^{-03}$ |

If the display reads:
0.005, the current setting is Type B | **0.005** |

④ Press [MODE][9] to switch between the Type A and Type B lower limits.

*Note that the lower limit is not changed if you press [MODE][9] while the number of significant digits (SCI displayed) and/or the number of decimal places (FIX displayed) are specified. The first time you press [MODE][9], you clear the FIX and SCI specifications, and so you must press [MODE][9] again to change the lower limit.

2/ORDER OF OPERATIONS AND LEVELS

Operations are performed in the following order of precedence:

1. Functions
2. x^y, $x^{1/y}$, R→P, P→R, nPr, nCr
3. ×, ÷
4. +, −
5. AND } BASE-N mode
6. OR, XOR, XNOR } BASE-N mode

Operations with the same precedence are performed from left to right, with operations enclosed in parentheses performed first. If parentheses are nested, the operations enclosed in the innermost set of parentheses are performed first.
*Registers L_1 through L_6 are provided to store operations of lower precedence (including parenthetical operations). Since six registers are provided, calculations up to six levels can be retained.
*Since each level can contain up to three open parentheses, parantheses can be nested up to 18 times.

Ex.) (4 levels, 5 nested parentheses)

Operation:

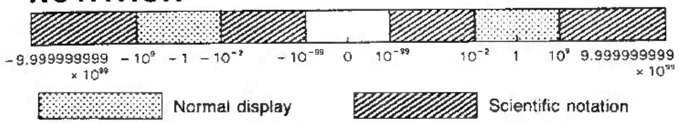
2 [×] [(] [(] [(] 3 [+] 4 [×] [(] [(] 5 [+] 4 [)] [÷] 3 [)] [)] [÷] 5 [)] [+] 9 [)] [=]

1 level 1 level 1 level 1 level A

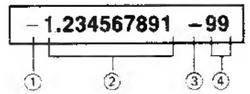
Register contents at point A.

x	4
L_1	[([(5 +
L_2	4 ×
L_3	[([([(3 +
L_4	2 ×
L_5	
L_6	

3/CALCULATION RANGE AND SCIENTIFIC NOTATION



When the answer exceeds the normal display capacity, it is automatically shown by scientific notation, 10-digit mantissa and exponents of 10 up to ±99.



① The minus (−) sign for mantissa
② The mantissa
③ The minus (−) sign for exponent
④ The exponent of ten

The whole display is read: $-1.234567891 \times 10^{-99}$

*Entry can be made in scientific notation by using the [EXP] key after entering the mantissa.

EXAMPLE	OPERATION	READ-OUT
$-1.234567891 \times 10^{-3}$ (= −0.001234567891)		
	1 [·] 234567891 [+/−]	− 1.234567891
	[EXP]	− 1.234567891 00
	3 [+/−]	− 1.234567891 − 03

4/CORRECTIONS

If you notice an input mistake before you press the arithmetic operation key, simply press [C] to clear the value and enter it again.
In a series of calculations, you can correct errors in intermediate results by recalculating correctly when the error appears and then continuing with the original series from where you interrupted it.

If you make a mistake by pressing the wrong key when entering [+], [−], [×], [÷], [x^y] or [SHIFT][$x^{1/y}$], simply press the appropriate key to correct. In this case, the most recently pressed key operation is used, but it retains the order of precedence of the original operation entered.

5/OVERFLOW OR ERROR CHECK

Overflow or error is indicated by the "-E-" or "-[-" sign and stops further calculation.

Overflow or error occurs:

a) When an answer, whether intermediate or final, or accumulated total in the memory is more than 1×10^{100} ("-E-" sign appears).
b) When function calculations are performed with a number exceeding the input range ("-E-" sign appears).
c) When the ranges for any of the number systems used in the BASE-N mode are exceeded. ("-E-" sign appears).
d) When unreasonable operations are performed in statistical calculations ("-E-" sign appears).
e) When the total number of levels of explicity and/or implicity (with addition-subtraction versus multiplication-division including x^y and $x^{1/y}$) nested parentheses exceeds 6, or more than 18 pairs of parentheses are used ("-[-" sign appears).
   Ex.) You have pressed the [(---] key 18 times continuously before designating the sequence of [2][+][3][×].

To release these overflow checks:

a), b), c), d)...... Press the [AC] key.
e)...................... Press the [AC] key. Or press the [C] key, and the intermediate result just before the overflow occurs is displayed and the subsequent calculation is possible.

Memory protection:

The content of the memory is protected against overflow or error and the accumulated total is recalled by pressing the [MR] key after the overflow check is released by the [AC] key.

6/POWER SOURCE

The CASIO C-POWER system makes it possible to operate calculators any place even in complete darkness; you don't have to worry about the light conditions.

- This unit protects memory no matter what the light conditions.
- This unit uses two power sources: an amorphous silicon solar cell, and a lithium battery (GR927).

- A weakened lithium battery is indicated when the memory contents spontaneously clear or when the display darkens under poor light conditions and cannot be restored by pressing the [ON] key. Anytime such symptoms occur, the unit should be taken to your retailer or nearby dealer for battery replacement.
- Lithium battery replacement should only be performed by your retailer or an authorized dealer.
- To ensure proper operation the lithium battery should be replaced once every six years no matter how much the unit is used.

Auto power-off function

This unit automatically switches OFF if not operated for approximately 6 minutes. Power can be restored by pressing the [ON] key. Memory contents and mode setting are retained even when power is switched off.

7/NORMAL CALCULATIONS

- You can perform normal calculations in the RUN mode ([MODE][.]).
- Calculations can be performed in the same sequence as the written formula (true algebraic logic).
- Nesting of up to 18 parentheses at 6 levels is allowed.

7-1 Four basic calculations (incl. parenthesis calculations)

EXAMPLE	OPERATION	READ-OUT
$23 + 4.5 - 53 =$	23[+]4[.]5[−]53[=]	−25.5
$56 \times (-12) \div (-2.5) =$	56[×]12[+/-][÷]2[.]5[+/-][=]	268.8
$2 \div 3 \times (1 \times 10^{20}) =$	2[÷]3[×]1[EXP]20[=]	6.666666667 19
$\underline{7 \times 8} - \underline{4 \times 5}(= 56 - 20) =$	7[×]8[−]4[×]5[=]	36.
$1 + 2 - \underline{3 \times 4 \div 5} + 6 =$	1[+]2[−]3[×]4[÷]5[+]6[=]	6.6
$\frac{6}{4 \times 5} =$	4[×]5[÷]6[SHIFT][x↔y][=]	0.3

- The number of levels of the [(---] key can be displayed.

EXAMPLE	OPERATION	READ-OUT
$2 \times \{7 + 6 \times (5 + 4)\} =$	2[×][(---]	[01 0.
	7[+]6[×][(---]	[02 0.
	5[+]4[---)][---)][=]	122.

- It is unnecessary to press the [---)] key before the [=] key.

EXAMPLE	OPERATION	READ-OUT
$10 - \{7 \times (3 + 6)\} =$	10[−][(---]7[×][(---]3[+]6[=]	−53.

Another operation: 10[−][(---]7[×][(---]3[+]6[---)][---)][=]

7-2 Constant calculations

*The "K" sign appears when a number is set as a constant.

Example	Operation	Display
3 + 2.3 =	2 [.] 3 [+] [+] 3 [=]	K 5.3
6 + 2.3 =	6 [=]	K 8.3
2.3 × 12 =	12 [×] [×] 2 [.] 3 [=]	K 27.6
(−9) × 12 =	9 [+/−] [=]	K −108.
17 + 17 + 17 + 17 =	17 [+] [+] [=]	K 34.
	[=]	K 51.
	[=]	K 68.
1.7^2 =	1 [.] 7 [×] [×] [=]	K 2.89
1.7^3 =	[=]	K 4.913
1.7^4 =	[=]	K 8.3521
3 × 6 × 4 =	3 [×] 6 [×] [×]	K 18.
3 × 6 × (−5) =	4 [=]	K 72.
	5 [+/−] [=]	K −90.
$\frac{56}{4 \times (2+3)}$ =	4 [×] [(---] 2 [+] 3 [---)] [÷] [÷]	K 20.
	56 [=]	K 2.8
$\frac{23}{4 \times (2+3)}$ =	23 [=]	K 1.15

7-3 Memory calculations using the independent memory

*When a new number is entered into the independent memory by the [SHIFT] [Min] key, the previous number stored is automatically cleared and the new number is put in the independent memory.
*The "M" sign appears when a number is stored in the independent memory.
*The contents accumulated into the independent memory are preserved even after the power switch is turned off.
To clear the contents press [0] [SHIFT] [Min] or [AC] [SHIFT] [Min] in sequence.

Example	Operation	Display
53 + 6 = 59	53 [+] 6 [=] [SHIFT] [Min]	M 59.
23 − 8 = 15	23 [−] 8 [M+]	M 15.
56 × 2 = 112	56 [×] 2 [M+]	M 112.
+) 99 ÷ 4 = 24.75	99 [÷] 4 [M+]	M 24.75
210.75	[MR]	M 210.75

7 + 7 − 7 + (2 × 3) + (2 × 3) + (2 × 3) − (2 × 3) =

Operation	Display
7 [SHIFT] [Min] [M+] [SHIFT] [M−] 2 [×] 3 [M+] [M+] [M+] [SHIFT] [M−] [MR]	M 19.

Example	Operation	Display
12 × 3 = 36	3 [×] [×] 12 [=] [SHIFT] [Min]	M K 36.
−) 45 × 3 = 135	45 [SHIFT] [M−]	M K 135.
78 × 3 = 234	78 [M+]	M K 234.
135	[MR]	M K 135.

7-4 Memory calculations using 6 constant memories

*When a new number is entered into a constant memory by operating ENTRY [Kin] ([1] to [6]), the previous number stored is automatically cleared and the new number is put in the constant memory.
*The contents stored in the constant memories are preserved even after the power switch is turned off.
To clear the contents press [0] [Kin] [1] (to [6]) or [AC] [Kin] [1] (to [6]) in sequence.

Example	Operation	Display
193.2 ÷ 23 =	193 [.] 2 [Kin] [1] [÷] 23 [=]	8.4
193.2 ÷ 28 =	[Kout] [1] [÷] 28 [=]	6.9
193.2 ÷ 42 =	[Kout] [1] [÷] 42 [=]	4.6

*Another operations by using the independent memory:
193 [.] 2 [SHIFT] [Min] [÷] 23 [=], [MR] [÷] 28 [=], [MR] [÷] 42 [=]

Example	Operation	Display
$\frac{9 \times 6 + 3}{(7-2) \times 8}$ =	9 [×] 6 [+] 3 [=] [Kin] [1]	57.
	[(---] 7 [−] 2 [---)] [×] 8 [=] [Kin] [2]	40.
	[Kout] [1] [÷] [Kout] [2] [=]	1.425

*Calculations in constant memory registers can also be performed by using the [+], [−], [×] and [÷] keys.

7 × 8 × 9 = 504
4 × 5 × 6 = 120
3 × 6 × 9 = 162

(Total) 14 19 24 786

Operation	Display
7 [Kin] [1] [×] 8 [Kin] [2] [×] 9 [Kin] [3] [=] [SHIFT] [Min]	M 504.
4 [Kin] [+] [1] [×] 5 [Kin] [+] [2] [×] 6 [Kin] [+] [3] [M+]	M 120.

	3[Kin][+][1][×]6[Kin][+][2][×]9[Kin][+][3][M+]	M 162.
	[Kout][1]	M 14.
	[Kout][2]	M 19.
	[Kout][3]	M 24.
	[MR]	M 786.

$12 \times (2.3 + 3.4) - 5 =$

$30 \times (2.3 + 3.4 + 4.5) - 15 \times 4.5 =$

12[×][(]2[·]3[+]3[·]4[)][Kin][1][−]5[=]	63.4
30[×]4[·]5[Kin][+][1] [SHIFT][X↔K][1] [−]15[×][Kout][1][=]	238.5

To exchange the displayed number (4.5) with the contents of constant memory 1.

7-5 Fraction calculations

* Total of integer, numerator and denominator must be within 10 digits (includes division marks).
* A fraction can be transferred to the memory.
* When a fraction is extracted, the answer is displayed as a decimal.
* A press of [a b/c] key after the [=] key converts the fraction answer to the decimal scale.

$4\frac{5}{6} \times (3\frac{1}{4} + 1\frac{2}{3}) \div 7\frac{8}{9} =$

4[a b/c]5[a b/c]6[×][(]3[a b/c]1[a b/c]4[+]1[a b/c]2[a b/c]3[)][÷]7[a b/c]8[a b/c]9[=]	3⌟7⌟568.
[a b/c]	3.012323944
[a b/c]	3⌟7⌟568.

$2\frac{4}{5} + \frac{3}{4} - 1\frac{1}{2} =$

2[a b/c]4[a b/c]5[+]3[a b/c]4[−]	3⌟11⌟20.
[a b/c]	3.55
1[a b/c]1[a b/c]2[=]	2⌟1⌟20.

$(1.5 \times 10^7) - \{(2.5 \times 10^6) \times \frac{3}{100}\} =$

1[·]5[EXP]7[−]2[·]5[EXP]6[×]3[a b/c]100[=]	14925000.

* During a fraction calculation, a figure is reduced to the lowest terms by pressing a function command key ([+], [−], [×] or [÷]) or the [=] key if the figure is reducible.

$3\frac{456}{78} = 8\frac{11}{13}$ (Reduction)

3[a b/c]456[a b/c]78	3⌟456⌟78.
[=]	8⌟11⌟13.

* By pressing [SHIFT][d/c] continuously, the displayed value will be converted to the improper fraction.

Continuing from above [SHIFT][d/c]	115⌟13.

$\frac{12}{45} - \frac{32}{56} =$

12[a b/c]45[−]	4⌟15.
32[a b/c]56[=]	−32⌟105.

* The answer in a calculation performed between a fraction and a decimal is displayed as a decimal.

$\frac{41}{52} \times 78.9 =$

41[a b/c]52[×]	41⌟52.
78[·]9[=]	62.20961538

7-6 Percentage calculations

12% of 1500	1500[×]12[SHIFT][%]	180.
Percentage of 660 against 880	660[÷]880[SHIFT][%]	75.
15% add-on of 2500	2500[×]15[SHIFT][%][+]	2875.
25% discount of 3500	3500[×]25[SHIFT][%][−]	2625.

300cc is added to a solution of 500cc. What is the percent of the new volume to the initial one?

300[+]500[SHIFT][%]	160.

(%)

If you made $80 last week and $100 this week, what is the percent increase?

100[−]80[SHIFT][%]	25.

(%)

12% of 1200	1200[×][×]12[SHIFT][%]	K 144.
18% of 1200	18[SHIFT][%]	K 216.
23% of 1200	23[SHIFT][%]	K 276.
26% of 2200	26[×][×]2200[SHIFT][%]	K 572.
26% of 3300	3300[SHIFT][%]	K 858.
26% of 3800	3800[SHIFT][%]	K 988.
Percentage of 30 against 192	192[÷][÷]30[SHIFT][%]	K 15.625
Percentage of 156 against 192	156[SHIFT][%]	K 81.25

*600 grams was added to 1200 grams. What percent is the total to the initial weight?
*510 grams was added to 1200 grams. What percent is the total to the initial weight?

Keys	Display
1200 [+] [+] 600 [SHIFT] [%]	K 150.
510 [SHIFT] [%]	K 142.5

*How many percent down is 138 grams to 150 grams?
*How many percent down is 129 grams to 150 grams?

Keys	Display
150 [−] [−] 138 [SHIFT] [%]	K −8.
129 [SHIFT] [%]	K −14.

8/BINARY/OCTAL/DECIMAL/HEXADECIMAL CALCULATIONS

- Binary/octal/decimal/hexadecimal calculations and conversions are performed in the BASE-N mode ([MODE] [0]).
- Base values are set by pressing one of the following keys:

KEY	BASE
[DEC]	Decimal
[HEX]	Hexadecimal
[SHIFT] [BIN]	Binary
[SHIFT] [OCT]	Octal

- Calculation range

BASE	DIGITS	RANGE
Binary	10 digits	Positive : $0 \leq x \leq 111111111$ Negative: $1000000000 \leq x \leq 1111111111$
Octal	10 digits	Positive : $0 \leq x \leq 3777777777$ Negative: $4000000000 \leq x \leq 7777777777$
Decimal	10 digits	Positive : $0 \leq x \leq 2147483647$ Negative: $-2147483648 \leq x < 0$
Hexadecimal	8 digits	Positive : $0 \leq x \leq$ 7FFFFFFF Negative: $80000000 \leq x \leq$ FFFFFFFF

- Valid values

BASE	VALUES
Binary:	0, 1
Octal:	0, 1, 2, 3, 4, 5, 6, 7
Decimal:	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Hexadecimal:	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

*Values other than noted above cannot be entered while each respective base is in effect. The letters B and D are displayed in lower case for hexadecimal.
*You cannot specify the unit of angular measurement (degrees, radians, grads) or the display format (FIX, SCI) while the calculator is in the BASE-N mode. Such specifications can only be made if you first exit the BASE-N mode.

8-1 Binary/octal/decimal/hexadecimal conversions

[MODE] [0] (BASE-N mode)

Operation	Keys	Display
Conversion of 22_{10} to binary	[DEC] 22 [SHIFT] [BIN]	10110. b
Conversion of 22_{10} to octal	[SHIFT] [OCT]	26. o
Conversion of 22_{10} to hexadecimal	[HEX]	16. H
Conversion of 513_{10} to binary	[DEC] 513 [SHIFT] [BIN]	−E− b

*Conversion may sometimes be impossible if calculation range of original value is greater than range of result value.

Operation	Keys	Display
Conversion of $7FFFFFFF_{16}$ to decimal	[HEX] 7FFFFFFF [DEC]	2147483647. d
Conversion of 4000000000_8 to decimal	[SHIFT] [OCT] 4000000000 [DEC]	−536870912. d
Conversion of 123456_{10} to octal	[DEC] 123456 [SHIFT] [OCT]	361100. o
Conversion of 1100110_2 to decimal	[SHIFT] [BIN] 1100110 [DEC]	102. d

8-2 Negative expressions

- Negative values can be obtained by pressing the [NEG] key. The two's complement is produced for negation of binary, octal, decimal and hexadecimal values.

[MODE] [0] (BASE-N mode)

Operation	Keys	Display
Negation of 1010_2	[SHIFT] [BIN] 1010 [NEG]	1111110110. b
Conversion to decimal	[DEC]	−10. d
Negation of 1_2	[SHIFT] [BIN] 1 [NEG]	1111111111. b
Negation of 2_8	[SHIFT] [OCT] 2 [NEG]	7777777776. o
Negation of 34_{16}	[HEX] 34 [NEG]	FFFFFFCC. H

8-3 Binary/octal/decimal/hexadecimal calculations

- Memory and parenthesis calculations can be used with binary, octal, decimal and hexadecimal number systems.

[MODE] [0] (BASE-N mode)

Operation	Keys	Display
$10111_2 + 11010_2 = 110001_2$	[SHIFT] [BIN] 10111 [+] 11010 [=]	110001. b
$123_8 \times ABC_{16} = 37AF4_{16}$	[SHIFT] [OCT] 123 [×] [HEX] ABC [=]	37AF4. H
$= 228084_{10}$	[DEC]	228084. d

$1F2D_{16} - 100_{10} = 7881_{10}$	[HEX] 1F2D [−] [DEC] 100 [=]	7881. d
$= 1EC9_{16}$	[HEX]	1EC9. H
$7654_8 \div 12_{10} = 334.3\cdots_{10}$	[SHIFT] [OCT] 7654 [÷] [DEC] 12 [=]	334. d
$= 516_8$	[SHIFT] [OCT]	516. o

*Fractional parts of calculation results are truncated.

$110_2 + 456_8 \times 78_{10} \div 1A_{16} = 390_{16}$		
$= 912_{10}$	[SHIFT] [BIN] 110 [+] [SHIFT] [OCT] 456 [×] [DEC] 78 [÷] [HEX] 1A [=]	390. H
	[DEC]	912. d

*Multiplication and division are given priority over addition and subtraction in mixed calculations.

$BC_{16} \times (14_{10} + 69_{10}) = 15604_{10}$		
$= 3CF4_{16}$	[HEX] BC [×] [(] [DEC] 14 [+] 69 [)] [=]	15604. d
	[HEX]	3CF4. H
$23_8 + 963_{10} = 982_{10}$	[SHIFT] [OCT] 23 [SHIFT] [Min] [+] [DEC] 963 [=]	M 982. d
$\underline{23_8} + 101011_2 = 111110_2$	[MR] [+] [SHIFT] [BIN] 101011 [=]	M 111110. b
$2A56_{16} \times \underline{23_8} = 32462_{16}$	[HEX] 2A56 [×] [MR] [=]	M 32462. H

8-4 Logical operations

•The [AND], [OR], [XOR], [XNOR] and [NOT] keys can be used to perform the respective binary, octal, decimal and hexadecimal logical operations.

[MODE] [0] (BASE-N mode)

19_{16} AND $1A_{16} = 18_{16}$	[HEX] 19 [AND] 1A [=]	18. H
1110_2 AND $36_8 = 1110_2$	[SHIFT] [BIN] 1110 [AND] [SHIFT] [OCT] 36 [=]	16. o
	[SHIFT] [BIN]	1110. b
23_8 OR $61_8 = 63_8$	[SHIFT] [OCT] 23 [OR] 61 [=]	63. o
120_{16} OR $1101_2 = 12D_{16}$	[HEX] 120 [OR] [SHIFT] [BIN] 1101 [=]	100101101. b
	[HEX]	12d. H
5_{16} XOR $3_{16} = 6_{16}$	[HEX] 5 [XOR] 3 [=]	6. H
$2A_{16}$ XNOR $5D_{16} = FFFFFF88_{16}$	[HEX] 2A [XNOR] 5D [=]	FFFFFF88. H

1010_2 AND $(A_{16}$ OR $7_{16}) = 1010_2$	[SHIFT] [BIN] 1010 [AND] [(] [HEX] A [OR] 7 [)] [=]	A. H
	[SHIFT] [BIN]	1010. b
$1A_{16}$ $\underline{\text{AND } 2F_{16}} = A_{16}$	[HEX] 2F [AND] [AND] 1A [=]	A. H
$3B_{16}$ $\underline{\text{AND } 2F_{16}} = 2B_{16}$	3B [=]	2b. H
NOT of 10110_2	[SHIFT] [BIN] 10110 [NOT]	1111101001. b
NOT of 1234_8	[SHIFT] [OCT] 1234 [NOT]	7777776543. o
NOT of $2FFFED_{16}$	[HEX] 2FFFED [NOT]	FFd00012. H

9/FUNCTION CALCULATIONS

Scientific function keys can be utilized as subroutines of four basic calculations (including parenthesis calculations).

*This calculator computes as $\pi = 3.141592654$ and $e = 2.718281828$.
*In some scientific functions, the display disappears momentarily while complicated formulas are being processed. So do not enter numerals or press the function key until the previous answer is displayed.
*You cannot specify the unit of angular measurement (degrees, radians, grads) or the display format (FIX, SCI) while the calculator is in the BASE-N mode. Such specifications can only be made if you first exit the BASE-N mode.
*For each input range of the scientific functions, see page 39.

9-1 Sexagesimal ↔ Decimal conversion

The [°'"] key converts the sexagesimal figure (degree, minute and second) to decimal notation. Operation of [SHIFT] [←°'"] converts the decimal notation to the sexagesimal notation.

14°25'36'' =	14 [°'"]	14.
	25 [°'"]	14.41666667
	36 [°'"]	14.42666667
	[SHIFT] [←°'"]	14°25°36.

9-2 Trigonometric/Inverse trigonometric functions

$\sin(\frac{\pi}{6}\text{rad}) =$	"R" ([MODE] [5]) [π] [÷] 6 [=] [sin]	0.5
cos 63°52'41'' =	"D" ([MODE] [4]) 63 [°'"] 52 [°'"] 41 [°'"]	63.87805556
	[cos]	0.440283084
tan(−35 gra) =	"G" ([MODE] [6]) 35 [+/-] [tan]	−0.612800788

$2 \cdot \sin 45° \times \cos 65° =$	"D" 2 [×] 45 [sin] [×] 65 [cos] [=]	0.597672477
$\cot 30° = \frac{1}{\tan 30°} =$	"D" 30 [tan] [SHIFT] [1/x]	1.732050808
$\sec(\frac{\pi}{3}\text{rad}) = \frac{1}{\cos(\frac{\pi}{3}\text{rad})} =$	"R" [π] [÷] 3 [=] [cos] [SHIFT] [1/x]	2.
$\text{cosec}\,30° = \frac{1}{\sin 30°} =$	"D" 30 [sin] [SHIFT] [1/x]	2.
$\cos^{-1}\frac{\sqrt{2}}{2} =$	"R" 2 [√] [÷] 2 [=] [SHIFT] [cos⁻¹]	0.785398163
$\tan^{-1}0.6104 =$	"D" [.] 6104 [SHIFT] [tan⁻¹]	31.39989118
	[SHIFT] [←°'"]	31°23°59.61

9-3 Hyperbolic functions and inverse hyperbolic functions

$\sinh 3.6 =$	3 [.] 6 [hyp] [sin]	18.28545536
$\tanh 2.5 =$	2 [.] 5 [hyp] [tan]	0.986614298
$\cosh 1.5 - \sinh 1.5 =$	1 [.] 5 [SHIFT] [Min] [hyp] [cos] [−]	M 2.352409615
	[MR] [hyp] [sin] [=]	M 0.22313016
	[ln]	M 1.5
$\sinh^{-1}30 =$	30 [SHIFT] [hyp] [sin]	4.094622224

Solve $\tanh 4x = 0.88$

$x = \frac{\tanh^{-1}0.88}{4} =$	[.] 88 [SHIFT] [hyp] [tan] [÷] 4 [=]	0.343941914

9-4 Common & Natural logarithms/Exponentiations (Common antilogarithms, Natural antilogarithms, Powers and Roots)

$\log 1.23 (= \log_{10} 1.23) =$	1 [.] 23 [log]	0.089905111

Solve $4^x = 64$.

$x \cdot \log 4 = \log 64$

$x = \frac{\log 64}{\log 4}$	64 [log] [÷] 4 [log] [=]	3.

$\ln 90 (= \log_e 90) =$	90 [ln]	4.49980967
$\log 456 \div \ln 456 =$	456 [SHIFT] [Min] [log] [÷] [MR] [ln] [=]	M 0.434294481
$10^{0.4} + 5 \cdot e^{-3} =$	[.] 4 [SHIFT] [10^x] [+] 5 [×] 3 [+/-] [SHIFT] [e^x] [=]	2.760821773
$5.6^{2.3} =$	5 [.] 6 [x^y] 2 [.] 3 [=]	52.58143837
$123^{1/7} (= \sqrt[7]{123}) =$	123 [SHIFT] [x^{1/y}] 7 [=]	1.988647795
$(78 - 23)^{-12}$	[(] 78 [−] 23 [)] [x^y] 12 [+/-] [=]	1.305111829 -21
$3^{12} + e^{10} =$	3 [x^y] 12 [+] 10 [SHIFT] [e^x] [=]	553467.4658
$\log \sin 40° + \log \cos 35°$	"D" 40 [sin] [log] [+] 35 [cos] [log] [=]	−0.278567983
	[SHIFT] [10^x]	0.526540784

(The antilogarithm . . . . 0.526540784)

$15^{1/5} + 25^{1/6} + 35^{1/7}$	15 [SHIFT] [x^{1/y}] 5 [+] 25 [SHIFT] [x^{1/y}] 6 [+] 35 [SHIFT] [x^{1/y}] 7 [=]	5.090557037

9-5 Square roots, Cube roots, Squares, Reciprocals & Factorials

$\sqrt{2} + \sqrt{3} \times \sqrt{5} =$	2 [√] [+] 3 [√] [×] 5 [√] [=]	5.287196909
$\sqrt[3]{5} + \sqrt[3]{-27} =$	5 [SHIFT] [∛] [+] 27 [+/-] [SHIFT] [∛] [=]	−1.290024053
$123 + 30^2 =$	123 [+] 30 [SHIFT] [x²] [=]	1023.
$\frac{1}{\frac{1}{3} - \frac{1}{4}} =$	3 [SHIFT] [1/x] [−] 4 [SHIFT] [1/x] [=] [SHIFT] [1/x]	12.
$8! (= 1 \times 2 \times 3 \times \ldots\ldots \times 7 \times 8)$	8 [SHIFT] [x!]	40320.

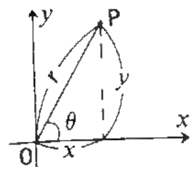
9-6 Miscellaneous functions (FIX, SCI, NORM, RND, RAN#, ENG)

Calculation	Key operation	Display
$1.234 + 1.234 =$	"FIX2" ([MODE] [7] [2]) 1 [.] 234 [+]	FIX 1.23
	1 [.] 234 [=]	FIX 2.47
	[MODE] [9]	2.468
	"FIX2" 1 [.] 234 [SHIFT] [RND] [+]	FIX 1.23
	1 [.] 234 [SHIFT] [RND] [=]	FIX 2.46
	[MODE] [9]	2.46
$\underline{1 \div 3} + \underline{1 \div 3}$	"SCI2" ([MODE] [8] [2]) 1 [÷] 3 [+]	SCI 3.3 – 01
	1 [÷] 3 [=]	SCI 6.7 – 01
	[MODE] [9]	0.666666666
	"SCI2" [(] 1 [÷] 3 [)] [SHIFT] [RND] [+]	SCI 3.3 – 01
	[(] 1 [÷] 3 [)] [SHIFT] [RND] [=]	SCI 6.6 – 01
	[MODE] [9]	0.66
$1 \div 1000 = 0.001 = 1 \times 10^{-3}$	(Norm 1) 1 [÷] 1000 [=]	1. – 03
	(Norm 2) [MODE] [9]	0.001
$123m \times 456 = 56088m = 56.088km$	123 [×] 456 [=]	56088.
	[ENG]	56.088 03
$7.8g \div 96 = 0.08125g = 81.25mg$	7 [.] 8 [÷] 96 [=]	0.08125
	[ENG]	81.25 – 03
Generate a random number between 0.000 and 0.999	[SHIFT] [RAN#]	0.570 (Example)

9-7 Polar to rectangular co-ordinates conversion

Formula $x = r \cdot \cos\theta \quad y = r \cdot \sin\theta$

Ex.) Find the value of x and y when the point P is shown as $\theta = 60°$ and length $r = 2$ in the polar co-ordinates



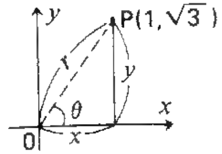
Key operation	Display
"D" 2 [SHIFT] [P→R] 60 [=]	1. (x)
[SHIFT] [X↔Y]	1.732050808 (y)

9-8 Rectangular to polar co-ordinates conversion

Formula $r = \sqrt{x^2 + y^2}$

$$\theta = \tan^{-1}\frac{y}{x} \quad (-180° < \theta \leqq 180°)$$

Ex.) Find the length r and angle θ in radian when the point P is shown as $x = 1$ and $y = \sqrt{3}$ in the rectangular coordinates



Key operation	Display
"R" 1 [SHIFT] [R→P] 3 [√] [=]	2. (r)
[SHIFT] [X↔Y]	1.047197551 (θ in radian)

9-9 Permutations

Input range: $n \geqq r$ (n, r: natural numbers)

Formula $nPr = \dfrac{n!}{(n-r)!}$

Ex.) How many numbers of 4 figures can be obtained when permuting 4 different numbers among 7 (1 to 7)?

7 [SHIFT] [nPr] 4 [=] → 840.

9-10 Combinations

Input range: $n \geqq r$ (n, r: natural numbers)

Formula $nCr = \dfrac{n!}{r!(n-r)!}$

Ex.) How many groups of 4 members can be obtained when there are ten in class.

10 [SHIFT] [nCr] 4 [=] → 210.

10/STATISTICAL CALCULATIONS

*Be sure to press [SHIFT] [KAC] in sequence prior to starting a statistical calculation.

10-1 Standard deviation

*Set the function mode to "SD" by pressing [MODE] [3].

Ex.) Find σ_{n-1}, σ_n, $\bar{x}$, n, Σx and Σx^2 based on the data 55, 54, 51, 55, 53, 53, 54, 52.

"SD" [SHIFT] [KAC] 55 [DATA] 54 [DATA] 51 [DATA] 55 [DATA] 53 [DATA] [DATA] 54 [DATA] 52 [DATA] → 52.

	Key operation	Display
(Sample standard deviation)	[SHIFT] [$x\sigma_{n-1}$]	1.407885953
(Population standard deviation)	[SHIFT] [$x\sigma_n$]	1.316956719
(Arithmetical mean)	[SHIFT] [$\bar{x}$]	53.375
(Number of data)	[Kout] [n]	8.
(Sum of value)	[Kout] [Σx]	427.
(Sum of square value)	[Kout] [Σx^2]	22805.

Calculate the unbiased variance and the deviation between each data item and the average.

	Key operation	Display
(Subsequently)	[SHIFT] [$x\sigma_{n-1}$] [SHIFT] [x^2]	1.982142857 (Unbiased variance)
	[SHIFT] [$\bar{x}$] [■] [■] 55 [=]	1.625 (55 − $\bar{x}$)
	54 [=]	0.625 (54 − $\bar{x}$)
	51 [=]	−2.375 (51 − $\bar{x}$)
	⋮	⋮

Note. The sample standard deviation σ_{n-1} is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

the population standard deviation σ_n is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n}}$$

and the arithmetical mean $\bar{x}$ is defined as

$$\frac{\Sigma x}{n}$$

*Pressing [$x\sigma_{n-1}$], [$x\sigma_n$], [$\bar{x}$], [n], [Σx] or [Σx^2] key need not be done sequentially.

Ex.) Find n, $\bar{x}$ & σ_{n-1} based on the data 1.2, −0.9, −1.5, 2.7, −0.6, 0.5, 0.5, 0.5, 0.5, 1.3, 1.3, 1.3, 0.8, 0.8, 0.8, 0.8, 0.8

	Key operation	Display
"SD"	[SHIFT] [KAC] 1 [.] 2 [DATA] [.] 9 [+/−] [DATA]	−0.9
1 (Mistake)	2 [.] 5 [+/−]	−2.5
1' (To correct)	[C]	0.
	1 [.] 5 [+/−] [DATA]	1.5
	2 [.] 7 [DATA]	2.7
2 (Mistake)	[DATA]	2.7
3 (Mistake)	1 [.] 6 [+/−] [DATA]	1.6
3' (To correct)	[SHIFT] [DEL]	−1.6
	[.] 6 [+/−] [DATA]	0.6
2' (To correct)	2 [.] 7 [SHIFT] [DEL]	2.7
	[.] 5 [×]	0.5
	4 [DATA]	0.5
4 (Mistake)	1 [.] 4 [×]	1.4
4' (To correct)	[AC]	0.
	1 [.] 3 [×] 3 [DATA]	1.3
	[.] 8 [×]	0.8
5 (Mistake)	6 [DATA]	0.8

⑤' (To correct)	[·] 8 [×] 6 [SHIFT] [DEL]	0.8
	[·] 8 [×] 5 [DATA]	0.8
	[Kout] [n]	17.
	[SHIFT] [$\bar{x}$]	0.635294117
	[SHIFT] [$x\sigma n$]	0.95390066

10-2 Regression analysis

*Set the function mode to "LR" by pressing [MODE] [2].

■ Linear regression

Formula $y = A + Bx$

$$A = \frac{\Sigma y - B\cdot\Sigma x}{n} \qquad B = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{n\cdot\Sigma x^2 - (\Sigma x)^2}$$

$$r = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{\sqrt{(n\cdot\Sigma x^2 - (\Sigma x)^2)(n\cdot\Sigma y^2 - (\Sigma y)^2)}}$$

Ex.) Results from measuring the length and temperature of a steel bar

temp	length
10°C	1003mm
15	1005
20	1010
25	1008
30	1014

Find the constant term (A), regression coefficient (B), correlation coefficient (r) and estimated values ($\hat{x}$, $\hat{y}$) using the above figures as a basis.

"LR"	[SHIFT] [KAC] 10 [xD,yD]	10.
	1003 [DATA]	1003.
	15 [xD,yD] 1005 [DATA]	1005.
	20 [xD,yD] 1010 [DATA]	1010.
	25 [xD,yD] 1008 [DATA]	1008.
	30 [xD,yD] 1014 [DATA]	1014.
	[SHIFT] [A]	998.
	[SHIFT] [B]	0.5 (B)
	[SHIFT] [r]	0.919018277 (r)

(When the temp. is 18°C)	18 [$\hat{y}$]	1007. (mm)
(When the length is 1000mm)	1000 [SHIFT] [$\hat{x}$]	4. (°C)

Note: Σx^2, Σx, n, Σy^2, Σy, Σxy, $\bar{x}$, $x\sigma n$, $x\sigma n{-}1$, $\bar{y}$, $y\sigma n$, $y\sigma n{-}1$, A, B and r are respectively obtained by pressing a numeral key ([1] to [9]) after the [Kout] or [SHIFT] key.

*Correction of data entry

Ex.)

x_i	2	3	2	3	2	4
y_i	3	4	4	5	5	5

"LR"	[SHIFT] [KAC] 2 [xD,yD] 3 [DATA]	3.
① (Mistake)	4	4.
①' (To correct)	[C]	0.
	3 [xD,yD]	3.
	4 [DATA]	4.
② (Mistake)	3 [xD,yD]	3.
②' (To correct)	2 [xD,yD]	2.
	4 [DATA]	4.
③ (Mistake)	1 [xD,yD]	1.
	5 [DATA]	5.
③' (To correct)	[SHIFT] [DEL]	5.
	3 [xD,yD] 5 [DATA]	5.
	2 [xD,yD]	2.
④ (Mistake)	4 [DATA]	4.
	4 [xD,yD]	4.
⑤ (Mistake)	6 [DATA]	6.
⑤' (To correct)	[SHIFT] [DEL]	6.
	4 [xD,yD] 5 [DATA]	5.
④' (To correct)	2 [xD,yD] 4 [SHIFT] [DEL]	4.
	2 [xD,yD] 5 [DATA]	5.

These ways of correction can also be applied to logarithmic, exponential or power regression.

■ Logarithmic regression

Formula $y = A + B \cdot \ln x$

* Input data items are the logarithm of x ($\ln x$), and y which is the same as in linear regression.
* Operation for calculating and correcting regression coefficients are basically the same as in linear regression. Operate the sequence x [ln] [ŷ] to obtain estimator $\hat{y}$ and y [SHIFT] [x̂] [SHIFT] [e^x] for estimator $\hat{x}$. Note that $\Sigma \ln x$, $\Sigma(\ln x)^2$, and $\Sigma \ln x \cdot y$ are obtained instead of Σx, Σx^2, and Σxy respectively.

Ex.)

xi	29	50	74	103	118
yi	1.6	23.5	38.0	46.4	48.9

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

"LR"

Operation	Display	
[SHIFT] [KAC] 29 [ln] [xD,yD]	3.36729583	
1 [.] 6 [DATA]	1.6	
50 [ln] [xD,yD] 23 [.] 5 [DATA]	23.5	
74 [ln] [xD,yD] 38 [DATA]	38.	
103 [ln] [xD,yD] 46 [.] 4 [DATA]	46.4	
118 [ln] [xD,yD] 48 [.] 9 [DATA]	48.9	
[SHIFT] [A]	111.1283963	(A)
[SHIFT] [B]	34.02014719	(B)
[SHIFT] [r]	0.994013942	(r)
(When xi is 80) 80 [ln] [ŷ]	37.9487947	($\hat{y}$)
(When yi is 73) 73 [SHIFT] [x̂] [SHIFT] [e^x]	224.1541338	($\hat{x}$)

■ Exponential regression

Formula. $y = A \cdot e^{B \cdot x}$

* Input data items are the logarithm of y ($\ln y$), and x which is the same as in linear regression.
* Operation for correction is basically the same as in linear regression. Operate [SHIFT] [A] [SHIFT] [e^x] to obtain coefficient A, x [ŷ] [SHIFT] [e^x] for estimator $\hat{y}$ and y [ln] [SHIFT] [x̂] for estimator $\hat{x}$. Note that $\Sigma \ln y$, $\Sigma(\ln y)^2$, and $\Sigma x \cdot \ln y$ are obtained instead of Σy, Σy^2, and Σxy.

Ex.)

xi	6.9	12.9	19.8	26.7	35.1
yi	21.4	15.7	12.1	8.5	5.2

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

"LR"

Operation	Display	
[SHIFT] [KAC] 6 [.] 9 [xD,yD]	6.9	
21 [.] 4 [ln] [DATA]	3.063390922	
12 [.] 9 [xD,yD] 15 [.] 7 [ln] [DATA]	2.753660712	
19 [.] 8 [xD,yD] 12 [.] 1 [ln] [DATA]	2.493205453	
26 [.] 7 [xD,yD] 8 [.] 5 [ln] [DATA]	2.140066164	
35 [.] 1 [xD,yD] 5 [.] 2 [ln] [DATA]	1.648658626	
[SHIFT] [A] [SHIFT] [e^x]	30.49758743	(A)
[SHIFT] [B]	−0.049203708	(B)
[SHIFT] [r]	−0.997247351	(r)
(When xi is 16) 16 [ŷ] [SHIFT] [e^x]	13.87915739	($\hat{y}$)
(When yi is 20) 20 [ln] [SHIFT] [x̂]	8.574868054	($\hat{x}$)

■ Power regression

Formula $y = A \cdot x^B$

* Input data items are $\ln x$ and $\ln y$.
* Operation for correction is basically the same as in linear regression. Operate [SHIFT] [A] [SHIFT] [e^x] to obtain coefficient A, x [ln] [ŷ] [SHIFT] [e^x] for estimator $\hat{y}$, and y [ln] [SHIFT] [x̂] [SHIFT] [e^x] for estimator $\hat{x}$. Note that $\Sigma \ln x$, $\Sigma(\ln x)^2$, $\Sigma \ln y$, $\Sigma(\ln y)^2$, and $\Sigma \ln x \cdot \ln y$ are obtained instead of Σx, Σx^2, Σy, Σy^2 and Σxy respectively.

Ex.)

xi	28	30	33	35	38
yi	2410	3033	3895	4491	5717

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

"LR"

Operation	Display	
[SHIFT] [KAC] 28 [ln] [xD,yD]	3.33220451	
2410 [ln] [DATA]	7.787382026	
30 [ln] [xD,yD] 3033 [ln] [DATA]	8.017307508	
33 [ln] [xD,yD] 3895 [ln] [DATA]	8.267448958	
35 [ln] [xD,yD] 4491 [ln] [DATA]	8.409830673	
38 [ln] [xD,yD] 5717 [ln] [DATA]	8.651199471	
[SHIFT] [A] [SHIFT] [e^x]	0.238801299	(A)

[SHIFT] [B] 2.771865947
(B)

[SHIFT] [r] 0.998906243
(r)

(When x_i is 40) **40** [ln] [ŷ] [SHIFT] [e^x] 6587.67572
($\hat{y}$)

(When y_i is 1000) **1000** [ln] [SHIFT] [x̂] [SHIFT] [e^x] 20.2622555
($\hat{x}$)

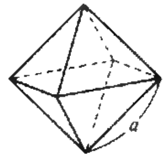
11/PROGRAMMED CALCULATIONS

- This calculator has a program memory of 38 steps. Up to two programmed procedures of calculation may be stored in the memory.
- To store a program (mathematical procedure) in the calculator, execute ordinary (i.e. manual) calculation in the LRN mode (press [MODE] [EXP]) only once.
- Now the calculator has memorized the program. Input data and press the [RUN] key, and the calculator executes the program with the data. This is very convenient for repeating calculations with varying sets of data.

■ How to store and execute programs

Ex. 1) Calculate the surface areas (S) of regular octahedrons whose ridges are respectively 10, 7 and 15 cm long.

Formula $S = 2\sqrt{3}\, a^2$



Ridge length (a)	Surface area
10 cm	(346.41) cm^2
7	(169.74)
15	(779.42)

*Values enclosed with parentheses are to be obtained.

- The following sequence of key operations realizes a mathematical procedure of the above formula.

2 [×] **3** [√] [×] **10** [SHIFT] [x^2] [=] → S
↑
Value of a (data)

- Operate the above sequence in the LRN mode ([MODE] [EXP]). Note that [ENT] must be pressed prior to data entry (the value of a in this case).

(Select LRN mode) [MODE] [EXP] — LRN P1 P2 0.
LRN and P1, P2 lit

(Designate program No.) [P1] — LRN P1 0.
Select a program area P1 or P2

(Input data)
2 — LRN P1 2.
[×] — LRN P1 2.
3 — LRN P1 3.
[√] — LRN P1 1.732050808
[×] — LRN P1 3.464101615
[ENT] 10 — LRN P1 10. ENT
[SHIFT] [x^2] — LRN P1 100.
[=] — LRN P1 346.4101615
S for a = 10

- The mathematical procedure is stored in P1.

Execution of the program stored

(LRN disappears)

(Select RUN mode) [MODE] [.] — 346.4101615

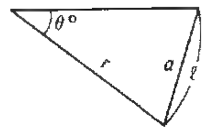
(Designate program No.) [P1] — P1 3.464101615 ENT
7 [RUN] — 169.7409791
S for a = 7

[P1] 15 [RUN] — 779.4228634
S for a = 15

Ex. 2) Calculate the length ℓ of the arc and the length a of the chord of a sector with radius and radii making an angle of $\theta°$.

$$\ell = \frac{\pi r \theta}{180}$$

$$a = 2r \sin\frac{\theta}{2}$$



Radius (r)	Angle of radii (θ)	Arc length (ℓ)	Chord length (a)
10 cm	60°	(10.47) cm	(10) cm
12	42°34'	(8.91)	(8.71)
15	36°	(9.42)	(9.27)

*The values enclosed with parentheses are to be obtained

(Select LRN mode) [MODE] [EXP] — LRN P1 P2 0.

(Designate program No.) [P2] — LRN P2 0.

[MODE] [4] [ENT] 10 — LRN P2 10.

$r \rightarrow$ To K1 register

[Kin] [1] [×] [ENT] 60 — LRN P2 60.

$\theta \rightarrow$ To K2 register

[Kin] [2] [×] [π] [÷] 180 [=] [SHIFT] [HLT] — LRN P2 10.47197551

HLT for displaying result (ℓ)

2 [Kin] [×] [1] [Kin] [÷] [2] — K1 × 2, K2 ÷ 2

[Kout] [2] [sin] [Kin] [×] [1] — $\sin \frac{\theta}{2} \times$ K1

[Kout] [1] — LRN P2 10.

Result (a)

Execution of the program stored

(LRN disappears)

(Select RUN mode) [MODE] [·] — 10.

(Designate program No.) [P2] — P2 10.

(Input r) 12 [RUN] — P2 12.

(Input θ) 42 [°'"] 34 [°'"] [RUN] — P2 8.915141819

Result (ℓ)

(Subsequently) [RUN] — 8.711524731

Result (a)

[P2] 15 [RUN] 36 [RUN] — P2 9.424777961

Result (ℓ)

(Subsequently) [RUN] — 9.270509831

Result (a)

■ Program step

• The program is stored (written) in the calculator as shown below

No. of steps	Program	No. of steps	Program
1	P1 2	15	×
2	×	16	π
3	3	17	
4	√	18	1
5	×	19	8
6	ENT	20	0
7	SHIFT x^2	21	
8	=	22	SHIFT HLT
9	P2 MODE 4	23	2
10	ENT	24	Kin × 1
11	Kin 1	25	Kin ÷ 2
12	×	26	Kout 2
13	ENT	27	sin
14	Kin 2	28	Kin × 1
		29	Kout 1

• The program capacity is 38 steps. The program may be divided into two areas (P1 and P2) and each can be used independently of the other.

• An error results ("-E-" displayed) when there is an attempt to write the 39th step. No subsequent steps can be written. In this case, press [AC] to release the error check.

• After the program is started, instruction steps are executed one after another and execution does not stop. But it is needed to halt execution for inputting a data or reading a result. This is accomplished by [ENT] and [SHIFT] [HLT].
When the end of a program is reached, execution stops automatically and the state is displayed. So, HLT may be absent.

• Each function comprises a step of program. The depression of keys in a certain sequence produces a single program step if it generates a single function.

1) Functions generated by the depression of a single key
Ex.) Numeral value, +/−, +, −, ×, ÷, =, [(,)], sin, log, ENT, . .

2) Functions generated by the depression of a two-key sequence
Ex.) hyp sin, SHIFT sin $^{-1}$, SHIFT X↔Y, SHIFT $x^{1/y}$, SHIFT R→P, Kout 2, Kin 3, SHIFT RAN#, ...
3) Functions generated by the depression of a three-key sequence
Ex.) SHIFT X↔K 5, SHIFT hyp sin $^{-1}$, MODE 8 3 (Assignment for the number of significant digits), ...

f you have misoperated when writing a program (i.e. in the LRN mode), press the sequence of [SHIFT] [PCL] and perform the correct operation.
The depression of a data entry key ([•], [0] — [9]) followed by [EXP], [%], [+/-] or [C] will not be written in if such a sequence immediately follows the depression of [ENT]. Note that one of the functions which does not follow a numeric data will be written in as a step.

x.) [ENT] 6 [+/-] 6 [+/-] 6 [+/-]
Not written in
[ENT] 6 [+/-] [+/-] [+/-]
Not written in Written (2 steps)

How to erase a program

n old program will be automatically overwritten by a new program if the same program umber is assigned to them.
o erase a program for making corrections or erase all 38 steps, operate the following equence.

To erase a single program (P1 or P2).
[MODE] [EXP] [P1] (or [P2]) [SHIFT] [PCL]
↑
Selects the LRN mode.

To erase both P1 and P2.
[MODE] [EXP] [SHIFT] [PCL]

Jump instructions

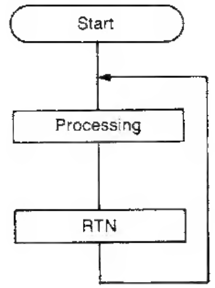
here are two types of jump instructions as follows.

Unconditional return to the first step of program: RTN
Write the sequence of [SHIFT] [RTN] at the end of a program to execute it repeatedly.
Ex.) Let us use the unconditional return instruction in the regular octahedron program explained on page 29. (In this case, the formula must be modified to $S = a^2 \times 2\sqrt{3}$.)

Operation: [MODE] [EXP] [P1]
[ENT] 10 [SHIFT] [x^2] [×] 2 [×] 3 [√] [=] [SHIFT] [RTN]
↑ Value of a ↑ Return instruction

Step No.	Instruction step
1	ENT
2	SHIFT x^2
3	×
4	2
5	×
6	3
7	√
8	=
9	SHIFT RTN

Flowchart



(Select RUN mode) [MODE] [•] 0.

(Designate program No.) [P1] P1 0.

(For $a = 7$) 7 [RUN] P1 169.7409791

Result S for $a = 7$

(For $a = 15$) 15 [RUN] P1 779.4228634

Result S for $a = 15$

*If a program includes an RTN instruction but neither ENT nor HLT, the program will, once started, not stop in an endless loop. To stop the program in such a case, press [AC].

2. Return to the first step of program depending on the condition of the contents of the X-register (display): $x > 0$, $x \leq M$

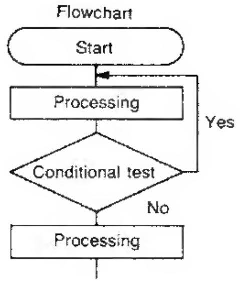
$x > 0$: Return to the first step of program if the contents of the X-register is greater than zero and go to the next step otherwise.
$x \leq M$: Return to the first step of program if the contents of the X-register is equal to or smaller than the contents of the M-register and otherwise go to the next step.

Ex.) Find the maximum of 456, 852, 321, 753, 369, 741, 684 and 643.

Operation: [MODE] [EXP] [P1]
[ENT] [SHIFT] [X↔M] [SHIFT] [Min]

Step No.	Instruction step
1	ENT
2	SHIFT $x \leq$ M
3	SHIFT Min

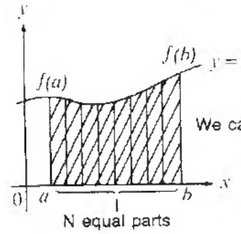
Yes
No



Key operation	Display
MODE · AC SHIFT Min	0.
	Memory cleared
(Designate P1) P1	P1 0. ENT
(Input data) 456 RUN	456.
P1 852 RUN	852.
P1 321 RUN	P1 321. ENT
753 RUN	P1 753. ENT
369 RUN	P1 369. ENT
741 RUN	P1 741. ENT
684 RUN	P1 684. ENT
643 RUN	P1 643. ENT
MR	P1 852. ENT
	Maximum displayed

12/INTEGRALS

• To carry out integrals, ① define (write) function $f(x)$ during the LRN mode, then ② designate the interval of integral during the $\int dx$ mode.



We calculate area $\int_a^b f(x)\,dx$.

• The approximation method used for integrating the function written in P1 or P2 is the Simpson's rule. This method requires to divide the interval of integral into equal parts. If the number of divisions is not specified, the calculator determines it by itself according to the form of the function. To specify it, designate n (an integer of 1 to 9) which meets $N = 2^n$ where N is the number of divisions.

■ Defining funciton $f(x)$

1) Select the LRN mode (press MODE EXP).
2) Designate a program number (press P1 or P2).
3) Press SHIFT Min.
   • This is needed, as the first program step, to assign variable x of the function $f(x)$ to the M-register.
4) Write the expression of function $f(x)$ by true algebraic logic. Use MR to represent variable x. Write = at the end.

Ex.) For $f(x) = \dfrac{1}{x^2+1}$, write the sequence of 1, ÷, [(, MR, SHIFT x^2, +, 1,)], =

5) Press MODE 1 to select the $\int dx$ mode.

Note: For a function $f(x)$ whose variable x cannot take the zero value, input an appropriate number in between steps 1) and 2) above.
Do not use constant registers, KAC, ENT and HLT during expressing a function (step 4).

■ Execution of integral

1) Select the $\int dx$ mode (press MODE 1).
2) Designate the program number assigned to the function, $f(x)$. (Press P1 or P2.)
3) Press a sequence of n SHIFT RUN to specify division number N (this will be displayed). This step may be skipped.
4) Designate the interval of integral, [a, b]. (Press a RUN b RUN.)
   • In seconds or minutes the result will be displayed in a floating point representation.

: this time the memory registers contain the following data.

1-register	(Press [Kout][1])	.... a
2-register	(Press [Kout][2])	.... b
3-register	(Press [Kout][3])	.... $N\ (=2^n)$
4-register	(Press [Kout][4])	.... $f(a)$
5-register	(Press [Kout][5])	.... $f(b)$
6-register	(Press [Kout][6])	.... $\int_a^b f(x)dx$
-register	(Press [MR])	.... a

x.) For $f(x)=2x^2+3x+4$, calculate $\int_2^5 f(x)dx$ and $\int_2^8 f(x)dx$.

Writing $f(x)$

	Key operation	Display
(Select LRN mode)	[MODE][EXP]	LRN P1 P2 0.
(Designate program No.)	[P1]	LRN P1 0.
	[SHIFT][Min]	LRN P1 0.
(Write $f(x)$)	2[×][MR][SHIFT][x^2][+]3[×][MR][+]4[=]	

$\int_2^5 f(x)dx$

	Key operation	Display
(Select $\int dx$ mode)	[MODE][1]	∫dx 4.
(Designate program No.)	[P1]	∫dx P1 0. ENT
(Input n)	2[SHIFT][RUN]	∫dx P1 4. ENT
		N displayed
(Input a and b)	2[RUN]5[RUN]	∫dx 1.215000000 02

Result displayed in about 4 seconds

$\int_2^8 f(x)dx$

	Key operation	Display
(Designate program No.)	[P1]	∫dx P1 0. ENT
(Input a and b)	2[RUN]8[RUN]	∫dx 4.500000000 02

Result displayed in about 6 seconds

[Kout][1]	∫dx 2.	a
[Kout][2]	∫dx 8.	b
[Kout][3]	∫dx 8.	N
[Kout][4]	∫dx 18.	$f(a)$
[Kout][5]	∫dx 156.	$f(b)$
[Kout][6]	∫dx 450.	$\int_a^b f(x)dx$

■ Remarks for execution of integrals

- If you press [AC] during execution of integral (nothing is displayed), the execution will be aborted and the state selected by the depression of [MODE][1] entered.
- If no function $f(x)$ is defined (written in), the calculator will carry out integral for $f(x)=x$.
- It is normal to set the angular mode to "[R]" when executing integral of trigonometrics.
- Integral approximated by the Simpson's rule may take much execution time to raise the accuracy of result. Error may be large even when much execusion time has been consumed. If the number of significant digits of result is smaller than one, error termination occurs ("-E-" displayed).

  In such cases, dividing the integral interval will reduce execution time and raise accuracy:

  1. If the result varies greatly when the integral interval is moved slightly:
     Divide the interval into sections and sum up the results obtained in the sections.
  2. For a periodic function or if the value of integral becomes positive or negative depending on the interval:
     Calculate for each period or separately for the sections where the result of integral is positive from where the result is negative, and sum up the results obtained.
  3. If long execution time is due to the form of the function defined:
     Divide the function, if possible, into terms, execute integral for each term separately, and sum up the results.

13/SPECIFICATIONS

BASIC OPERATIONS

4 basic calculations, constants for $+/-/\times/\div/x^y/x^{1/y}$/AND/OR/XOR/XNOR, parenthesis calculations and memory calculations.

BUILT-IN FUNCTIONS

Trigonometric/inverse trigonometric functions (with angle in degrees, radians or grads), hyperbolic/inverse hyperbolic functions, common/natural logarithms, exponential functions (common antilogarithms, natural antilogarithms), powers, roots, square roots, cube roots, squares, reciprocals, factorials, conversion of coordinate system (R→P, P→R), permutations, combinations, random number, π, fractions, percentages, binary, octal, decimal and hexadecimal calculations and logical operations.

STATISTICAL FUNCTIONS
Standard deviation, linear regression, logarithmic regression, exponential regression, and power regression.

INTEGRALS
Simpson's rule.

MEMORY
1 independent memory and 6 constant memories.

CAPACITY
Entry/basic calculations

10-digit mantissa, or 10-digit mantissa plus 2-digit exponent up to $10^{\pm 99}$

Fraction calculations

Total of integer, numerator and denominator must be within 10 digits (includes division marks).

Scientific functions	Input range
$\sin x/\cos x/\tan x$	$\lvert x \rvert < 9 \times 10^9$ degrees ($< 5 \times 10^7 \pi$ rad, $< 10^{10}$ gra)
$\sin^{-1}x/\cos^{-1}x$	$\lvert x \rvert \leqq 1$
$\tan^{-1}x$	$\lvert x \rvert < 10^{100}$
$\sinh x/\cosh x$	$\lvert x \rvert \leqq 230.2585092$
$\tanh x$	$\lvert x \rvert < 10^{100}$
$\sinh^{-1}x$	$\lvert x \rvert < 5 \times 10^{99}$
$\cosh^{-1}x$	$1 \leqq x < 5 \times 10^{99}$
$\tanh^{-1}x$	$\lvert x \rvert < 1$
$\log x/\ln x$	$10^{-99} \leqq x < 10^{100}$
e^x	$-10^{100} < x \leqq 230.2585092$
10^x	$-10^{100} < x < 100$
x^y	$\begin{cases} x>0 \rightarrow -10^{100} < y \cdot \log x < 100 \\ x=0 \rightarrow y>0 \\ x<0 \rightarrow y : \text{integer or } 1/2n+1 \ (n\text{: integer}) \end{cases}$
$x^{1/y}$	$\begin{cases} x>0 \rightarrow y \neq 0 \quad -10^{100} < 1/y \cdot \log x < 100 \\ x=0 \rightarrow y>0 \\ x<0 \rightarrow y : \text{odd number or } 1/n \ (n\text{: integer}) \end{cases}$
$\sqrt{x}$	$0 \leqq x < 10^{100}$
x^2	$\lvert x \rvert < 10^{50}$
$\sqrt[3]{x}$	$\lvert x \rvert < 10^{100}$
$1/x$	$\lvert x \rvert < 10^{100}$ ($x \neq 0$)
$x!$	$0 \leqq x \leqq 69$ (x : integer)
$n\mathrm{P}r/n\mathrm{C}r$	$0 \leqq r \leqq n$, $n < 10^{10}$ (n, r : positive integer) *Certain combinations or permutations may cause errors due to overflow during internal calculations.
REC→POL	$\sqrt{x^2+y^2} < 10^{100}$
POL→REC	$\lvert \theta \rvert < 9 \times 10^9$ degrees ($< 5 \times 10^7 \pi$ rad, $< 10^{10}$ gra), $0 \leqq r < 10^{100}$

° ' "	up to second
π	10 digits

***Output accuracy**

± 1 in the 10th digit.

Binary	Positive :	$0 \leqq x \leqq 111111111$
	Negative:	$1000000000 \leqq x \leqq 1111111111$
Octal	Positive :	$0 \leqq x \leqq 3777777777$
	Negative:	$4000000000 \leqq x \leqq 7777777777$
Decimale	Positive :	$0 \leqq x \leqq 2147483647$
	Negative:	$-2147483648 \leqq x < 0$
Hexadecimal	Positive :	$0 \leqq x \leqq$ 7FFFFFFF
	Negative:	80000000 $\leqq x \leqq$ FFFFFFFF

*Errors are cumulative with such internal continuous calculations as x^y, $x^{1/y}$, $x!$, $\sqrt[3]{\ }$, $n\mathrm{P}r$, $n\mathrm{C}r$ so accuracy may be adversely affected.

*In $\tan x$, $\lvert x \rvert \neq 90° \times (2n+1)$, $\lvert x \rvert \neq \pi/2\text{rad} \times (2n+1)$, $\lvert x \rvert \neq 100\text{gra} \times (2n+1)$ (n is an integer.)

*With $\sinh x$ and $\tanh x$, errors are cumulative and adversely affected when $x=0$.

PROGRAMMABLE FEATURES
Total number of steps: up to 38 (1 step performs a function).
Jump: Unconditional jump (RTN), Conditional jump ($x>0$, $x \leqq$ M).
Number of programs storable: up to 2 (P1 and P2).

DECIMAL POINT
Full floating with underflow.

EXPONENTIAL DISPLAY
Norm 1 — $10^{-2} > \lvert x \rvert$, $\lvert x \rvert \geqq 10^{10}$
Norm 2 — $10^{-9} > \lvert x \rvert$, $\lvert x \rvert \geqq 10^{10}$

READ-OUT
Liquid crystal display, suppressing unnecessary 0's (zeros).

POWER SOURCE
Power source: Amorphous silicon solar cell, lithium battery (GR927)
Lithium battery life: 6 years with GR927 (1-hour daily use).

AMBIENT TEMPERATURE RANGE
0°C – 40°C (32°F – 104°F)

DIMENSIONS
8.5mmH × 73mmW × 140mmD ($^3/_8$"H × 2$^7/_8$"W × 5$^1/_2$"D)

WEIGHT
60 g (2.1 oz)